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(71) Applicant *(for all designated States except US)*: L.K. TOOL COMPANY LIMITED [GB/GB]; East Midlands Airport, Castle Donington, Derby DE7 2SA (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)* : STOTT, Christopher [GB/GB]; 56 Lockington Close, Chellaston, Derby (GB). SALT, Howard, Trevor [GB/GB]; 38 Station Road, Hatton, Derbyshire DE6 5EL (GB).

(74) Agent: DREVER, Ronald, Fergus; Swindell & Pearson, 48 Friar Gate, Derby DE1 1GY (GB).

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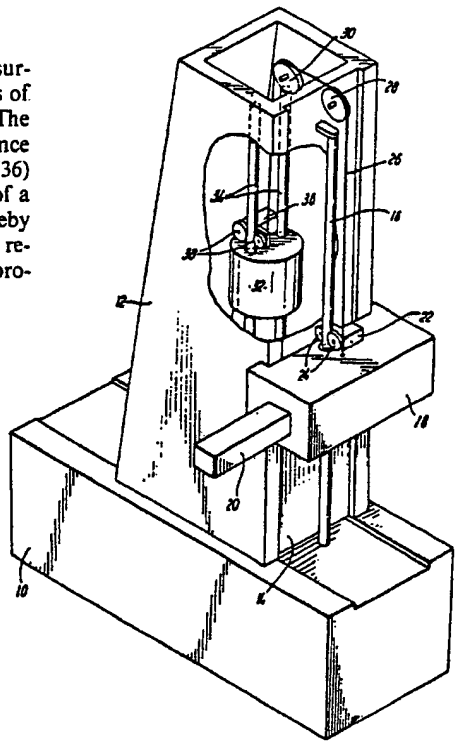
(54) Title: COMPONENT CONTROL APPARATUS IN MEASURING MACHINES

(57) Abstract

For movably mounting a measuring probe on a co-ordinate measuring machine, a carriage (18) has an electric motor (22) which, by means of rollers (24), provides a friction drive relation with a traction bar (16). The carriage (18) is connected by way of a wire rope (26) with a counterbalance deadweight (32). The latter has connected thereto an electric motor (36) providing a drive relation by means of a pair of rollers (38) with one of a pair of guide bars (34). The total mass of the motor arrangement is thereby split, with one arrangement compensating for the other and the power requirement is halved because the two motors share the total load. This provides for many operating advantages.



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Component Control Apparatus in Measuring Machines

This invention relates to component control apparatus, particularly in high accuracy co-ordinate measuring machines.

In one design, such machines conventionally can comprise a base structure providing a guideway for horizontal movement of a column which extends vertically from the base structure. The column provides a support for a vertically movable carriage which in turn locates a horizontally movable quill on which a measuring probe is mounted. Such a machine provides for three co-ordinate measurement or checking of a workpiece. The carriage movement is effected by an electric motor arrangement driving a rigidly connected carriage and counterbalance structure, the counterbalance being required to compensate for the combined weight of the carriage and the motor arrangement.

According to the present invention there is provided component control apparatus comprising a support structure for a component provided thereon, means with the component for moving the latter along a first elongate path on the structure, means interconnecting the component with counterbalance means, and means with the counterbalance means for moving the latter along a second elongate path parallel to

the first elongate path in a direction opposed to that of the component, motive forces applied to each moving means being substantially equal.

Preferably each moving means is an electric motor providing a friction drive relation with respective traction means, and each electric motor may drive one of a pair of rollers, the latter having a friction drive relation with a traction bar. The electric motors are desirably the same and are connected or wired in parallel to ensure that both have the same power output. The interconnecting means may comprise a line connected at respective ends to the component and the counterbalance means, and may be in the form of a wire rope extending across pulleys.

The invention also provides a measuring machine comprising a base structure, a further structure vertically arranged on the base structure and movable therealong, a component vertically movable on the further structure, and a component control apparatus as described in either of the two preceding paragraphs.

The component is desirably movable along a guide on an external face of the column with the counterbalance means movable within the column.

An embodiment of the present invention will now be described by way of example only, with reference to the single figure of the accompanying drawings, which is a part schematic perspective view of a measuring machine, partly cut away to show internal features.

Referring to the drawing, a co-ordinate measuring machine comprises a base structure 10 providing a horizontal guideway along which a column 12 is movable, the column 12 extending substantially vertically from the base 10. On an outer guiding face 14 of the column 12 there is provided a linear guideway, the guiding face 14 also mounting a drive or traction bar 16 for a purpose hereinafter described. A carriage 18 is provided to move vertically along the guideway, the carriage 18 carrying a horizontal quill 20 on which is mounted a measuring probe (not shown) for measurement or checking of a workpiece in a conventional manner.

An electric motor 22 mounted on the carriage 18 provides drive to one of a pair of rollers 24 which engage the bar 16 from opposed sides thereof and thereby provide a friction drive relation with the bar 16 when the motor 22 is operative.

The carriage 18 is connected to one end of a flexible line, for example in the form of a wire rope 26. The latter

extends upwardly from the carriage 18 and passes over a first freely rotatable pulley 28 mounted at the guide face 14 of the column 10. The rope 26 then travels substantially horizontally and passes over a further freely rotatable pulley 30 located internally of the column 12, thereafter to extend vertically downwardly from the pulley 30 and be connected at its other end to a counterbalance deadweight 32. The latter is movable along a pair of guide bars 34 and has connected thereto an electric motor 36 also providing drive to one of a pair of rollers 38 which locate on opposed sides of one of the guide bars 34 to be in a friction drive relation therewith. The motor 36 is identical to, and connected in series with the motor 22 so that both motors take the same current and therefore have the same power output. The motors could alternatively be connected in parallel.

In a conventional system the total mass of the motor arrangement has to be compensated for by the counterbalance deadweight. With the present design, the total mass of the motor arrangement is split between the carriage 18 and the counterbalance deadweight 32, one motor arrangement thereby compensating for the other. The power requirement of the motor to be mounted on the carriage 18 is halved, because there are two motors sharing the total load. This permits a doubling of possible vertical axis acceleration with no increase in carriage mass, or alternatively a maintenance of

the machine performance with a significant decrease in mass by the use of a smaller carriage motor. In the latter event the dynamic performance of the machine is improved as the stiffness of the structure remains as previously but with a reduced mass.

When the carriage 18 and the counterbalance deadweight 32 are driven by the respective motors in opposite directions, any difference in acceleration between the motors 22,36, for example due to inaccuracies between the drive pulleys 24 and 38 or due to differing friction forces in the bearings, will slightly change the tension within the wire rope 26. Any such change will create a greater power requirement on the motor which is accelerating at a greater speed, thus reducing the acceleration and causing the other motor to increase its acceleration, thereby sharing the power. The whole drive system thereby moves at a mean acceleration with the more efficient side helping the other. The system is accordingly self-compensating and enables just one tachogenerator signal to be monitored in order to control the total system. Fluctuations in the tensile forces within the wire rope 26 are largely eliminated, thus eliminating the need for passive damping within the counterbalance deadweight 32 and leaving virtually no vibration within the carriage 18 due to counterbalance influences, after a vertical positioning move.

Various maodifications may be made without departing from the invention. For examples the type of drive arrangments may be other than those described and shown and the relative positioning of components such as the free pulleys may differ from that description and shown. A chain may be utilised instead of a wire rope.

The base structure may be of the type described in our co-pending U.K. Application No. 8808282 entitled "Support Assemblies" with a temperature control as described in our co-pending U.K. Application No. 8808281 entitled "Support Structures". Further the machine components may be constructed as described in our co-pending U.K. Application No. 8808280 entitled "Machine Structure".

The invention can be utilised in other types of machine, such as a measuring machine having a movable bridge structure, a horizontally moving carriage, and a vertically moving quill with counterbalance.

Claims:-

1. Component control apparatus comprising a support structure for a component provided thereon, means with the component for moving the latter along a first elongate path on the structure, means interconnecting the component with counterbalance means, and means with the counterbalance means for moving the latter along a second elongate path parallel to the first elongate path in a direction opposed to that of the component, motive forces applied to each moving means being substantially equal.

2. Apparatus according to Claim 1, wherein each moving means is an electric motor providing a friction drive relation with respective traction means.

3. Apparatus according to Claim 2, wherein each electric motor drives one of a pair of rollers, the latter having a friction drive relation with a traction bar.

4. Apparatus according to claim 2 or 3, wherein the electric motors are the same and are wired or connected in series to ensure that both have the same power input.

5. Apparatus according to claim 2 or 3, wherein the electric motors are the same and are wired or connected in parallel.

6. Apparatus according to any of the preceding Claims, wherein the interconnecting means comprises a line connected at respective ends to the component and the counterbalance means.

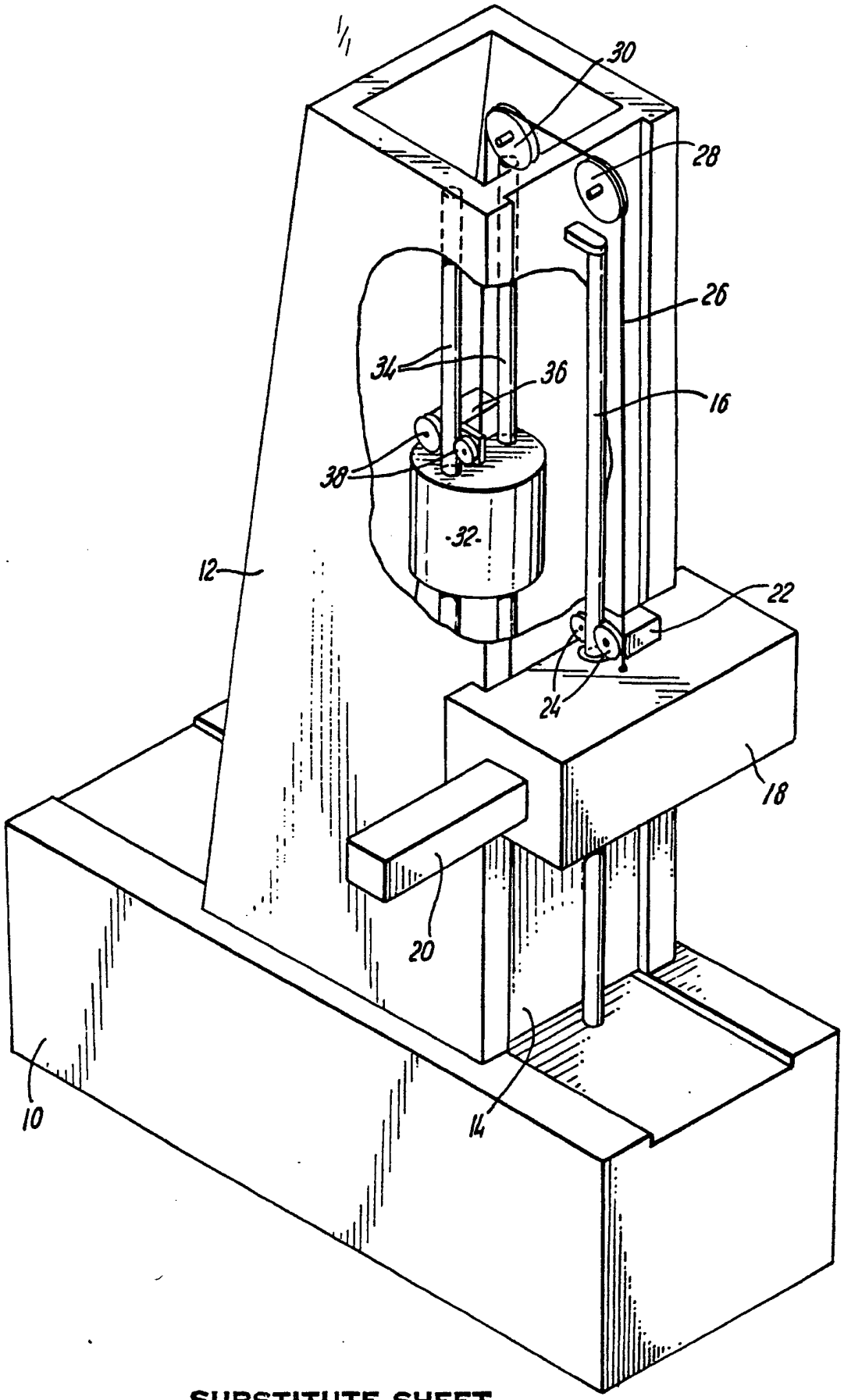
7. Apparatus according to any of the preceding Claims, wherein the interconnecting means is in the form of a wire rope extending across pulleys.

8. A measuring machine comprising a base structure, a further structure vertically arranged on the base structure and movable therealong, a component vertically movable on the further structure, and a component control apparatus according to any of the preceding Claims.

9. A machine according to Claim 8, wherein the component is movable along a guide on an external face of the column with the counterbalance means movable within the column.

10. Component control apparatus substantially as hereinbefore described with reference to the accompanying drawing.

11. A measuring machine substantially as hereinbefore described with reference to the accompanying drawing.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INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 89/00348

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: G 01 B 5/00, B 23 Q 11/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	G 01 B, B 23 Q

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	WO, A, 88/02471 (ARMBUSTER) 7 April 1988, see abstract; figures	1,8
A	US, A, 3351047 (C.E. BARKER) 7 November 1967, see column 1, line 70 - column 2, line 68; figures	1
A	DE, C, 646093 (H. LINDNER) 9 June 1937, see the whole document	1
A	Patent Abstracts of Japan, vol. 6, no. 156 (P-135)(1034), 17 August 1982 & JP, A, 5773601 (MITSUTOYO SEISAKUSHO K.K.) 8 May 1982, see the whole abstract	1
A	EP, A, 0160340 (PHILIPS) 6 November 1985, see figures	1

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
10th July 1989	03. 08. 89
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	N. VAN MOL

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 8900348 SA 27890

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 28/07/89
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A- 8802471	07-04-88	None	
US-A- 3351047		None	
DE-C- 646093		GB-A- 470159	
		US-A- 2118387	
EP-A- 0160340	06-11-85	DE-A- 3416000	07-11-85
		DE-A- 3564759	13-10-88
		JP-A- 61000330	06-01-86
		US-A- 4630796	23-12-86